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Introduction to Warehousing & Inventory

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Course Overview

This material is designed to introduce students to the concept of Warehousing and Inventory and their place in a Supply Chain. This unit contains sufficient information to give students an overall view of the role that Warehousing and Inventory fulfils in the context of Logistics. It is designed to equip them with a solid foundation of knowledge on which they can build with experience, and consists of five sections that relate to different aspects of Warehousing and Inventory, which are as follows:

- **Section 1 – Inventory** This section describes what inventory is and its purpose. It describes how we can categorise stock to suit our purpose and our approach when deciding how much stock we should hold. It then looks at how well, or otherwise, we are managing our inventory by evaluating our performance in this respect.
- **Section 2 – The Warehouse** In this section, we examine why we have a warehouse and the role it fulfils for us. We then consider the costs we incur in running a warehouse, the need for security and the importance of health & safety.
- **Section 3 – Warehousing Principles** The first consideration regarding a warehouse is where it should be located, and this section gives an insight into the reasons behind the choice of location. Then we look at how best to use a warehouse's total available space and how to achieve a smooth flow of product throughout.
- **Section 4 – Storage and Materials Handling** In this section, we consider the mechanisation of our materials handling and storage processes in order to make the most efficient use of our warehouse. We then look at what machinery/equipment is available and how it should be used and maintained.
- **Section 5 – Warehousing Processes** Simplistically, in our warehouses we receive goods, store them for a while and then despatch them. In this section, we look at the variety of processes that we carry out in order to do this in an effective and efficient manner.

1. Inventory

1.1 Learning Outcomes

a. Describe the purpose of inventory

b. Describe the different categories of stock and how to identify them

c. Summarise the factors that decide how much stock is held

d. Assess how to evaluate inventory performance

1.2 A Definition of Inventory

'Inventory' is the overall name we give to all items that we keep for any reason in order to run our business, which means that it is a very broad description. However, all these items can be allocated to three main groupings.

For example, we would keep an inventory of all our assets – items that the company actually owns. For our offices, we would list equipment such as desks and chairs, cupboards, filing cabinets, computers and their associated hardware. Similarly, our transport department would keep an inventory of their vehicles, tools and equipment.

Another group of items we must keep inventories to support our operations is our maintenance, repairs and operating supplies (MRO). In our offices this would be stationery, pens and so on. In the transport department, their MROs would include spare parts, nuts and bolts, lubricants etc.

The other group of stock items are those used to support production these include raw materials and work-in-process (WIP) items.

All these inventories should be properly managed and checked for accuracy – in the case of consumables some of them quite frequently, possibly weekly, but in the case of assets it may be just once a year. This is the process we commonly call 'stocktaking'.

However, the largest, and in some ways the most important group, consists of the products held so that we can fulfil our customers' orders in a timely manner and as fully as possible. This group of items comprises of finished goods of a variety depending on the type of product range we are providing to our customers. In a straightforward warehousing and distribution environment, these would be the ones held in our warehouse from which we would prepare our customers' orders for delivery.

It is this group that we will mainly concentrate on in this learning material.

We should not forget, however, that in a manufacturing environment our stocks may be held in a variety of different formats such as raw materials, work-in-progress, pre-assembled parts and components made or bought in, as well as finished products.

Task 1.1

Name five products from each of the main types of groupings from within your own company (or your own past experience).

Task 1.2

For each of the products you have identified in Task 1.1, state the frequency of their stocktaking and explain the reasons for any differences.

1.3 The Purpose of Inventory

Inventory is stock we keep in order to satisfy our customers' demand. Therefore, the most convenient approach would be to hold in stock plenty of everything so that whenever we receive a customer's order, whatever it is for, we can immediately prepare the order and supply everything asked for. However, taking into account the amount of stock we would have to hold in order to achieve this makes it impractical, if not impossible, in most cases.

Not only would we tie up too much of our money in the high levels of stock we would have to purchase, but also in the cost of obtaining and holding stock e.g. space, labour and other utilities. Ideally, therefore, we should keep just enough of each of our stock requirements to be able to fulfil our customers' demand until we can make replacements or receive the next delivery from our supplier.

Task 1.3

Explain how a company seeks to provide a high level of customer order completion.

There are, however, occasions when we might choose to buy more than our immediate requirements of stock for a variety of reasons such as:

- To make use of favourable currency exchange rates
- To make savings through bulk-purchase or other discounted rates
- To cope with seasonal variations
- To insure against erratic/unreliable supplies
- To protect ourselves from imminent price increases
- In order to prepare for a promotion

Task 1.4

Does your company, or one that you are familiar with, ever buy excess products? If so, explain why.

1.4 The Cost of Inventory

When considering the cost of our inventory, it is important to consider how to value the existing stock. To do this, we must first allocate a stock price to each item. This will ensure that when valuation comparisons are made, like-for-like figures are compared. There are a number of different approaches that we might take such as:

- **Cost price** –the actual purchase price. This is all very good in theory, but in practice it has a number of pitfalls as different batches received at different times may well have been bought at different prices. This makes comparisons of costs and budgets unreliable.
- **Average price** – each time a batch is delivered at a different price, a new average price must be calculated. This again makes comparisons of costs and budgets unreliable.
- **Market price** – the cost of replacing the stock. Again, this has similar disadvantages.
- **Selling price** – sometimes used to assess the performance of sales depots and finished product warehouses. Again, this has similar disadvantages.

  Standard price – devised specifically to overcome the shortcomings of the other methods by providing a realistic base for the comparison of costs and budgets. It requires that items are charged into stock at a standard price that has been forecast as realistic for a reasonable operating period, say one year. During this period, the items are charged ex-stock at the standard price as well.

Task 1.5

Which of the above pricing systems would be most applicable for your company or an organisation you are familiar with? Explain the reasons for your choice.

Having valued the stock, we must consider the other costs incurred by our inventory such as:

- Handling costs – the products must be received by our Goods-inwards department and then put into storage, which requires staff and equipment.
- Storage costs – for the building heat/light/power, rates/rent/depreciation
- Administration costs – maintenance of stock records, stocktaking
- Security and insurance
- Stock loss/damage/deterioration
- Opportunity costs – a term used to describe the money tied up in stock and we have therefore lost the opportunity to invest it elsewhere.

1.5 The Control of Inventory

We have seen that it is necessary to always have just enough stock of each item to fulfil our customers' orders, without holding too much

unnecessary stock. The process by which we achieve this is our Inventory Management Process. This consists of a number of separate, but linked, activities as follows:

1.5.1 Determination of current demand

Understanding the true demand as opposed to the apparent demand, which is what the customer wants as opposed to what can actually be supplied. In order to obtain an understanding of the current demand of an item of stock, the quantity on its own is insufficient information. Say we are told that the current demand for an item is 100, it is necessary to first determine the time period – a day, a week, a month? Then we need to know the frequency – every time, every other time, was it a one-off? Is this item a seasonal one and is this demand in or out of its season? So, if we then determine that the current demand for this item is 100 every week and this has been stable for some weeks now and it is not seasonal, we are pretty safe in using this figure as its current demand. So an item might be:

- predictive, random or rogue
- stable or seasonal
- fast or slow moving
- recurring or non-recurring

Statistical models and techniques assist us with the identification of these patterns and trends through the manipulation of historical data, but we must have an understanding of why these movements fluctuate.

Task 1.6

Identify five different products and explain what you believe to be their demand patterns.

1.5.2 Demand forecasting

We would base this on the determination of current demand and then apply additional relevant factors. Having determined the current demand for an item, it is necessary to try and understand what the future demand is likely to be. In order to do this, we need to know if there are any external factors that might influence this or whether the demand is predictable and likely to remain stable.

There are two main approaches that are used to estimate future demand. These are referred to as ‘subjective’ and ‘objective’ methods. When we rely on experience in making our estimates we are therefore using the subjective approach to forecasting. This is quite common in some organisations especially when there are no reliable data available. Care must be taken though to use experienced people in this approach.

The other objective approach sometimes called quantitative forecasting, involves mathematical analysis of historical data. There are a number of statistical forecasting models and techniques which can be employed to analyse time series data such as the following examples:.

- Simple averages – here we divide the sum of a set of data value by the number of sets in the data set. However, this ignores any increasing or decreasing trend present and we should only use it where demand is stable such as in the table below:

Period	Demand
1	55
2	52
3	50
4	48
5	45
Totals	250

Table 1.1: Simple averages

In the example above, the demand total of 250 is divided by the number of periods (five) to give us a simple average of 50. This would only just be a

reasonable forecast for our next 1, 2 or 3 periods – or until we have additional data with which to make a fresh calculation.

If we maintained our stock level at 50 and assuming we use the above period demand figures, we are likely to run out of stock for periods 1, 2 and 3 and over stocking in periods 4 and 5.

Another approach to forecasting is using the weighted average. In this approach a weighting is assigned to each data usually a higher weight is given to the most recent data, e.g. in period 5 above. The restriction on the weighting is that all weights must add up to 1.

- Weighted averages – this recognises that a trend may exist in our data by giving more emphasis to the most recent data
- This is demonstrated in the following example:

Period	Demand	Weighting factor	Demand x Weight
1	55	.1	5.5
2	52	.15	7.8
3	50	.2	10.0
4	48	.25	12.0
5	45	.3	13.5
Totals	250	1	48.8

Table 1.2: Weighted Averages

The formula for the average of the weighted demand is:

$$\frac{\text{Sum Total(demand x Weight)}}{} = 48.8$$

Because we have given a much higher weighting to the most recent data we can consider our forecast to be more realistic than from the simple average method.

There is still a challenge with the above data, especially considering that some of it could be out-dated for our estimation. The moving average approach attempts to address this in that we ignore in our calculation old data in preference of most recent one.

- Moving averages – for this method we use a pre-determined number of periods and each time the forecast is re-calculated, the oldest data is dropped (which is then call lagged demand) from the calculation and the latest data is included.

Period	Demand		Period 5 Forecast data		Period 6 Forecast data
1	55		55		Lagged
2	52		52		52
3	50		50		50
4	48		48		48
5	45		Total 205		45
Totals	250				Total 195

Table 1.3: Moving Averages

For example, using the same data as above and using a 4-period moving average, the method would be:

In period 4, the calculation for the period 5 forecast would be the sum of periods 1, 2, 3 and 4 = 205, which divided by 4 = 51.25.

Performing a similar calculation in period 5 to obtain the forecast for period 6 would result in the period 1 demand of 55 becoming lagged (dropped) and the period 5 demand of 45 being included. So, the calculation would be the sum of periods 2, 3, 4 and 5 = 195, which divided by 4 = 48.75

- **Seasonal Profiles and Indices** – the level of average demand varies when an item has a seasonal pattern to its demand profile. By analysing previous demand data, we can identify a series of indices which we can then use to forecast our future demand.

  You may have already noticed that forecasting demand is not easy. Any forecast or estimate is subject to numerous variations that will make the

forecast demand different from actual demand. So in some cases we are likely to have a stock out or more likely a surplus.

There is a cost associated with stock out and this cost may be high a risk for some operations. Production may stop when raw materials or spare parts are not available, we may lose a key customer to our competitor should we run out of stock when the customer places an order.

- **Determination of safety stock levels** – In order to minimise the negative impacts of stock outs, organisations have maintained a certain level safety or buffer stock. This is a very important consideration which is based on the nature of operations and also the service level we wish to provide to our customers. We hold safety/buffer stock in order to counteract the effects of variations to both our supply and demand. This is distinct from cycle stock, which is the amount of stock we need to hold to meet the normal, predictable demand levels.
- **Supplier lead time management** – we need to understand how long it takes a supplier from receiving our order to actually delivering it and whether it is likely to be complete or only partially fulfilled. These are the variations that would affect our safety stock and reorder levels.
- **Stock replenishment** – Let us now assume we have determined our demand and decided on our maximum stock levels, we also have decided on the level of safety/buffer stock. The next decision we should make is when to replenish our used stock. If we fail to replenish we may end up using the safety/buffer stock until we run out of stock.
    - Two approaches are used to replenish independent demand, ie, the periodic review method and the reorder levels. Both approaches set out a fixed point when replenishment should be triggered.
    - In periodic review the fixed point is time based, for example, every two months, four months etc.
    - For re-order level the fixed point is on or at a quantity level at which we should start the process of reordering.

- Each one of the above has its advantages and disadvantages and you will find that most organisations use a combination of the two approaches for their stock replenishment

- **Stock identification** – our stock can consist of many different types of individual items and there may be many different users of the same stock item. This means that we need a common method of describing stock to avoid mistakes, confusion and duplication. Stock identification is the process where we allocate codes to ensure that individual items of stock can be easily identified.

The easiest way for us to identify an item is by name or word description, but the problem is that different people may describe the same item using different words. This can result in the unrecognised duplication of the same item within the inventory with consequent higher than necessary stockholding levels.

Where we have a large number or a wide variety of items in use, names and word descriptions alone are inadequate and can be ambiguous, so identification is usually by a code.

Coding can be sequential or structured

- Sequential codes are usually numeric numbers and mainly used in asset inventory coding although some structure is also associated with asset numbering.

- Structured codes follow a pattern, and provide more information than just the item identity. These codes will include information on the characteristics of the item, class, its exact location in the warehouse

A code may consist of any of the following:

- Alphabetical symbols (letters only)
- Alpha-numeric symbols (letters and numbers)
- Numeric symbols (numbers only)

The coding system we use needs to allow for the different characteristics of individual items being coded and the method of coding could be simply sequential or ‘structured’.

A flexible and widely used structured system is ‘digital significance coding’ such as the Brisch coding system, designed mainly for the engineering industry. In this system, there are two parts to the code and each figure in the code has a specific meaning. The ‘surname’ comes first and provides the broad item classification followed by the ‘forename’ which describes the item in detail -

Surname

- 1st figure = main classification
- 2nd figure = subgroup of the main classification
- 3rd figure = item classification

Forename

- 4th figure = length
- 5th figure = diameter
- 6th figure = type of head
- 7th figure = surface finish

So 123-4567 could mean:

- 1 = bought out parts
- 2 = fasteners and fixings
- 3 = nuts and bolts
- 4 = 2cm
- 5 = 10mm
- 6 = hex RD hex
- 7 = zinc coated

We would normally maintain the coding details of all stock items in a master file so that all their codes can be readily analysed and we can identify and rectify any duplicated stock items.

This categorisation of stock may also be used for accounting or analytical reasons.

Task 1.7

Describe a stock identification system that you might be aware of.

1.5.3 Stock classification

In order to maximise our service levels whilst minimising our costs, we would first carry out a stock analysis exercise. This is then used to assist us in keeping costs down through a process of stock classification that is used to determine stock holding levels.

The analysis technique frequently used is derived from the studies carried out by the economist Vilfredo Pareto, who determined that most of the value of a group of items was concentrated in a few individual items within the group. The result of his studies came to be known as the '80:20' rule, as typically 80% of the items only accounted for 20% of their total value. Alternatively 20% of the items may account for 80% of the total value. A further application of this rule suggests that in stock-holding/distribution terms, 80% of the business volume comes from 20% of the stock lines.

From these conclusions, an analysis technique called 'ABC' was derived which, when we apply it to a range of stock items arranged in descending popularity sequence, determines the most popular/valuable/fastest moving and then sub-splits the remainder into medium and slow in the following proportions:

- Category A items are the top 20% of the total range and require close control and checking, say once a week.
- Category B items are the middle 30% of the total range and require medium control, say once a month.
- Category C items are the bottom 50% and require minimum control, say once every three or four months.

Hence, our time (therefore cost) allocated to the control of each item is based on its classification , with most time being spent on the Category A

items and not spent unnecessarily checking the slowest moving items. Nevertheless, it is these slow moving items that we should analyse to determine if in fact there is any 'dead' stock which could possibly be disposed of and eliminated from the range.

Another benefit that can be derived from an ABC analysis is that we can set minimum/maximum stock levels for each category and also decide on what replenishment method to apply to each of the categories..

1.6 Reverse Logistics

For a variety of reasons including delivery refusal, damaged goods, items not wanted/ordered and so on, goods will sometimes be returned to us from delivery destinations. The way that the problem of 'returns' is managed becomes our company's Reverse Logistics policy and procedures.

It is quite possible that a number of returned items, after we have checked them, may be considered to be in a good enough condition to be put back into stock for us to re-issue. We might sell off slightly damaged goods at a discounted price, whereas badly damaged goods would be more likely to be stripped down to their component parts with just the good ones being re-used.

The major drivers to the implementation of our reverse logistics policies and procedures include:

- Any existing environmental law that may force companies to take back their products and the way they are to be treated
- Economic benefits of using recovered products and reduced disposal costs

When determining reverse logistics procedures, there are a number of factors that we must consider such as:

- What is being returned and what can be done with it?
- By who, how, when and where should the various recovery activities be carried out?

- Can any of the recovery activities be integrated with any existing activities?
- How can positive cost savings and/or environmental benefits be obtained?

There are some further areas we should consider if the reverse logistics process is to be the desired smooth flow, for example:

- Returned goods travel in the reverse direction to the originally designed delivery routes and vehicle movements. How can these reverse flows be integrated with the existing delivery system without having a detrimental (costly) effect?
- At what point in the supply chain should the recovery activities take place? The nearer this is to the distribution point, the better we can minimise our handling and transport costs, but it is the farthest point away from where the original manufacturing skills are. However, for good condition products to go back to stock for immediate resale, this is the best place/shortest route.

The successful implementation of a reverse logistics strategy can generate savings in our stockholding, transportation and waste disposal costs. There is also potential considerable benefit for our company to be viewed by its customers and the general public as a caring and environmentally conscious company.

Task 1.8

Describe how your company, or one that you are familiar with, disposes of its waste material in an environmentally friendly way.

1.7 Performance Indicators

Each department in a company requires targets and indicators to measure and monitor their performance and these targets should be aimed at fulfilling the company's own objectives. The overall aim of our inventory management function is to make all products available as and when they are required and to do this at minimum cost. The effectiveness of this can be measured by using a range of performance indicators, one example of which is:

- Demand satisfaction, which is the availability of our products for customer order fulfilment. We measure this as the percentage of total demand fulfilled from our stock. This measure can be applied to an individual product, a specific group of products or indeed a whole range of products. An example of this would be:

Customer	Customer order (mixed items)	Items supplied	Items not available
1	240	220	20
2	460	430	30
3	380	370	10
4	420	410	10
5	300	280	20
Totals	1800	1710	90

Table 1.4: Demand Satisfaction

Therefore, the demand satisfaction we have achieved, i.e. our service level, is 1710 as a percentage of 1800, which is 95%.

Task 1.9

If customer number 2's order was fully supplied at 460 items, how would this have affected our demand satisfaction level?

- The other side of product availability is ‘Stock-Outs’, so another useful measure is the number of times that customer orders cannot be fulfilled because some product is not available. Using the same table as above, therefore, our stock-out level would be 5%.
- An overview of our inventory management efficiency can be obtained by considering our ‘Stock Turn’. This considers the volume of outward movement of our products, which can be in units or financial terms, over a period of time – frequently; the annual sales figures are used. We would then calculate the average value, or volume, of the stocks held throughout the same period of time. By dividing this figure into the annual sales figure, we can calculate how many times in the year we have ‘turned over’ our stock. This measure is an important one as it relates the amount of money we have invested in our stock to the use that we make of it. It is important to note that stock turn rates vary between industries and even between products in the same industry. For example, in the distribution industry you could not compare the figures for a manufactured item such as a washing machine with fresh fruit and vegetable products that are delivered daily.

Task 1.10

If last year our average total stock value was £1,250,000 and our annual sales figure was £5,000,000 what was our stock turn figure?

Task 1.11

Using the following sales data:

Week 1 = 210, week 2 = 250, week 3 = 240, week 4 = 220, week 5 = 210

Calculate a forecast for week 6 using each of the following three techniques:

1. Simple average
2. Weighted average
3. 4-week moving average

Task 1.12

From the sales data given in the table, carry out an ABC analysis on the following products:

Product	Sales	Product	Sales	Product	Sales
X14	**147**	**Y32**	**587**	**Z44**	**159**
X15	**226**	**Y33**	**965**	**Z45**	**267**
X16	**365**	**Y34**	**483**	**Z46**	**624**
X17	**214**	**Y35**	**239**	**Z47**	**248**
X18	**258**	**Y36**	**871**	**Z48**	**387**
X19	**792**	**Y37**	**269**	**Z49**	**258**
X20	**351**	**Y38**	**897**	**Z50**	**247**
X21	**249**	**Y39**	**827**	**Z51**	**165**
X22	**135**	**Y40**	**568**	**Z52**	**874**
X23	**227**	**Y41**	**654**	**Z53**	**586**

2. The Warehouse

2.1 Learning Outcomes

By the end of this section you will be able to:

a. Describe the need for warehouses

b. Assess the major costs of warehouse operations

c. Classify the main threats to stock and how to deal with them

d. Summarise the main hazards that occur in warehouses

e. Demonstrate how organisations dispose of waste products

2.2 The Nature and Purpose of Warehouses

As we have seen in the first section of this learning material, all businesses have to carry an inventory of some kind. This inventory has to be kept somewhere and the obvious place for assets such as desks and chairs is in the offices where they are actually in use. Consumables such

as stationery we would keep in the office as close as possible to where they will be used – for example, the photocopying paper in the cabinet under the photocopier. It would not make sense for us to store in the office the nuts and bolts to be used in the garage – we would probably have a bin storage system for these in the workshop.

The products we intend to use for satisfying our customers' demand will invariably take up a lot more space than the examples above. This means that our warehouse will almost certainly be our largest storage area and, as such, a great deal of thought should be given to making it 'fit for purpose'. This will depend very much on the nature of our products and the kind of service and service levels we offer to our customers. For example, chilled or frozen products require temperature controlled storage, valuable items require secure storage etc.

Task 2.1

Describe three products that require special storage conditions and explain why.

There are instances where it can appear that the product to be moved can also be the customer. For example, this is generally the case with airports and coach stations where the people using them to be moved from one place to another, in other words being re-distributed via a terminal, are the customers who are paying for the service.

So the important thing about our warehouse is that it is an effective and efficient link in the total supply chain, so enabling the best possible service to our customers. Its geographic position, operating processes, transport links and so on all need to be the best possible.

As such, our warehouses should be viewed as places for the temporary storage of our inventory – they are not places of permanent storage. Why put something into storage at all if it is going to remain there permanently – which means you are never going to take it out?!

Consequently, our warehouses are mostly re-distribution centres and as such they have a primary aim to facilitate the movement of goods from suppliers to customers. This should be done in order to meet their demand in a timely and cost effective manner.

Some warehouses will hold little or no stock as re-distribution takes place immediately after the supplies arrive. Examples of this are seen in the distribution of fresh fruit, vegetables and particularly flowers. This type of warehouse would be more properly called a Transhipment Centre as the products are distributed straight away without any storage or being further processed in any way.

Task 2.2

Give an example of products or processes that you believe are suitable for transhipment activities.

The main role of our warehouse is therefore not the storage of products but the satisfaction of our customer demand; however, to achieve this we may have to store some product. This, though, must not only be temporary but also kept to a minimum in order to avoid the associated storage costs.

There are, however, a number of valid reasons for holding stock, which include the following:

- As a buffer/consolidation point between two production processes
- To cover demand during suppliers' lead-time
- To enable savings to be made through bulk purchases or discounts

- To cope with seasonal fluctuations
- To provide a variety of product in a centralised location
- The build up/holding of anticipation stocks (for example, before a new product launch)
- The build up and holding of investment stocks

We may also use our warehouse to reduce bulk purchased stocks down into smaller quantities, combining individual items from various storage locations, and therefore consolidating and completing order preparation activities for onward delivery to our customers.

Task 2.3

Identify a product and give valid reasons why your company, or one you are familiar with, might wish to store it.

2.3 Warehouse Issues

As we have already seen, we consider that warehouses are mostly distribution centres that exist primarily to facilitate the flow of goods and services to end-users. Warehouses are always under pressure to reduce costs, including inventory, and from customers constantly seeking improved service levels. Like transport operations, warehousing is an important link in a supply chain, as they control the quality of the service to our customers. The transport element is important because it is the final interface between us and our customers. Everyone concerned must work together to achieve the '7 Rights', which are:

- Right product
- Right time
- Right place

- Right quantity
- Right quality
- Right condition
- Right price

Should these standards not be achieved, our customer may decide to take their business elsewhere. Further, should the customer have a reason to complain, we may find that this will result in an increase in the number of goods being returned – with us having to bear the associated costs of increased reverse logistics.

Task 2.4

Normally all seven of the 'rights' are equally important. Identify and describe a situation where one of them may be of higher priority than the rest.

Warehouse management therefore involves considering the following issues:-

- The number and size (both area and cubic capacity) of warehouses
- Geographic location
- MHE equipment and asset tracking
- ICT systems used for customer order and stock control, warehouse performance and quality management
- Relationships to vehicles used for local delivery and long distance trunking

When determining the number, size and location of our warehouses, the correct solution will be the best compromise we can find between the number of warehouses that would enable us to provide the highest level of service and the number that will be the most economic to run and maintain – thus enabling us to provide the best possible service at the lowest possible price.

Imagine a scenario where we have to supply 100 customers, randomly spread throughout the country, and we want to give them the best possible service without considering the cost. Our solution would be to have 100 warehouses right next door to each customer, which would be dedicated to fulfilling their every requirement. However, it is obvious that this structure would be prohibitively expensive.

Now imagine an alternative scenario where we have the same 100 customers but now we must satisfy their demand where the least expensive warehousing is the criteria. Our solution this time must be to have one single warehouse located at the central point of the total demand. However, this solution would possibly mean a lower level of service – probably to those customers farthest away from the warehouse.

By carrying out various depot location comparison exercises, somewhere between the two solutions will be found the best one. We sometimes refer this to ‘trade-off’ between transport delivery costs and warehousing costs.

A further issue related to the number of warehouses required is the management of our inventory levels. The principle here is that, immaterial of the number of warehouses used to supply our 100 customers, the cycle stock requirements to meet their combined demand will not alter. However, each warehouse would have to carry its own safety stocks, therefore the more warehouses we have, the more inventory we would have to carry in total.

With the now virtually universal adoption of computers that make use of electronic data interchange (EDI) for both home and commercial applications, a wide range of warehouse management systems are readily available to us. Starting from the most basic stock recording, they extend to highly complex real time, fully integrated systems that cover every aspect of warehouse management.

The link between home use and the commercial use of computers is the internet, which has allowed purchases to be made remotely and has consequently encouraged the development of 'e-tailing'. This in its turn requires a different approach to the logistics of supplying the demand created by this market as this may be carried out directly from a warehouse and the product may never have to pass through a retail outlet. In fact, there are companies that never hold stock of the items that they market. Instead, on receipt of a customer's order they pass this on to a manufacturer/supplier who would then deliver it directly to the purchaser.

Further, with the purchasing process having been speeded up, the customers' expectations of a similarly speeded up delivery for their purchase has increased pressure on the suppliers to achieve this through 'smarter' supply chains.

Task 2.5

Describe an e-tail purchase you (or someone known to you) has made and how easy/clear/convenient this was.

2.4 Warehouse Costs

Warehousing is a major cost element in our total supply chain and as a percentage of the total cost of distribution, the warehousing element averages about 35%. Individual warehouse running costs vary widely depending on the nature of their operations; however, the Freight Transport Association (FTA) has issued guidelines in which it suggests the main costs are as follows:

- Staffing
- Building services, maintenance and facilities management

- Warehouse equipment including the maintenance of materials handling equipment (MHE) and of vehicles

Warehouse costs can be divided into fixed and variable cost elements and this is an important distinction for monitoring and control purposes.

- Fixed costs are those that stay the same, irrespective of the level of activity. Examples of these are items such as:
  - rent and rates on premises,
  - heat, power and light,
  - insurance on premises,
  - depreciation of capital items or long-term rental charges,
  - basic and fixed wages such as salaries with all the added costs for pensions, national health insurance etc.

It is important to remember that the characteristic of all these costs is that they remain the same, whether the warehouse is busy or not.

- Variable costs are those that change as activity increases or decreases. Examples of these costs are items such as:
  - overtime wages,
  - variable bonuses, and
  - running costs for equipment (fuel, tyres, maintenance).
- All of these costs vary in line with the level of activity. For example, overtime wages will be high if the warehouse is very busy, but low or non-existent if it is not.

Task 2.6

Name three fixed costs and three variable costs which are applicable to your work or study environment.

We can group our fixed and variable costs under similar headings to those suggested by the Freight Transport Association (FTA) in the UK as above, in which case the relative proportions would approximate to the following:

- Staffing costs covering all wages, salaries and added costs for pensions etc. at, say, 60% of the total costs
- Buildings costs covering rent and rates, heat, power and lighting for premises at, say, 25% of the total costs
- Equipment costs covering appropriate fixed and variable items such as depreciation and running costs at, say, 15 % of total costs

Note that the above is based on the UK environment and the approximation may be different in other regions of the world.

In addition to the total cost of providing and running our warehouse, we must not forget the reason for having one at all – we have it to house the products we wish to store. The cost of these products – our stock inventory – was examined in some detail in Section 1 of this learning material.

One of the ways of reducing our inventory costs, and therefore our warehouse costs, whilst at the same time improving our customer service, is to make use of the Information and Communication Technology (ICT) that is available to us. Modern ICT systems can give us real time management information about:

- Stock demand and forecasting
- Stock pallet location, space utilisation
- Stock visibility
- Vehicle utilisation/asset tracking

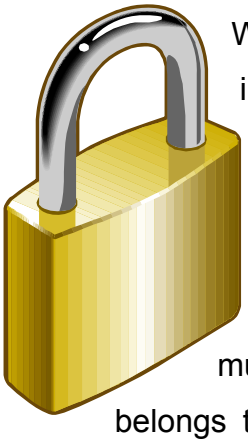
We have already seen that the fewer warehouses we have in our supply chain, the lower are our overall costs. The application of ICT may enable us to consolidate some of our warehouses, which would result in reducing our staffing levels and other overheads. Although initially costly, up to date materials handling equipment and order-picking systems that can make

good use of ICT systems and controls, would give us long-term cost benefits.

Task 2.7

Describe one way a company might use ICT to reduce its inventory costs.

2.5 Security in Warehouses



When thinking about the security of our warehouse, the initial reaction may well be to ensure that all the entrances and exits are locked and it would be difficult for anyone to break in. Of course, while this is an essential feature, real security goes much further than this. We should think of security as the measures we must take to stop anyone else from taking anything that belongs to our company, or that for which we are responsible, without our permission. By considering what actually belongs to us, our list would include such items as:

- Company assets, for example machinery, equipment, tools, spares
- Consumables such as stationery, lubricants, fuel
- Stock
- Data
- Information / knowledge

The first three on the list, being physical items, should be kept in a secure environment with access and all movements restricted to trained and authorised persons, who then record any movements in an appropriate manner.

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Information and knowledge are probably the most difficult items to keep secure as their existence is not necessarily apparent. Companies must ensure they follow secure practices such as limited access through passwords, back-up procedures and so on. Our role is to ensure we follow the rules and procedures in order to achieve maximum security and storage of our organisation's information.

Task 2.8

What approaches does your company take to ensure protection of its ICT information/data/systems?

There are some analytical approaches to these problems, two examples of which are:

- SWOT analysis, which is the analysis of the company's Strengths, Weaknesses, Opportunities and Threats. This tends to be a mix of internal and external influences.
- PESTLE analysis, which is the analysis of Political, Economic, Social, Technological, Legal and Environmental external influences that potentially could have an effect on the company.

Carrying out this type of analysis will in the main help us to identify business risks. There are, however, other risks – particularly to our inventory – that we must guard against such as:

- Theft
- Damage / deterioration
- Product going out of date
- Obsolescence – items may be superseded by technically superior products, rendering them surplus

- Fall in demand – seasonal demand may also influence stock levels and care should be taken to recognise and react to this type of trend
- Inaccurate stock accounting/checking – discrepancies between physical stocks and stock accounts can result in over/under ordering

Our stock audits, stock checks should address some of these problems. We shall come back to this aspect later in the sections below.

2.6 Health and Safety

Logistics and supply chain operations pose a high degree of danger to employees and other people that come into contact with our operations. This could be the reason why it can be argued that the most regulated industry is the logistics operations industry. Health and safety has also become a major ethical issue for most organisations' stakeholders. The key issue is what health and safety issues we should consider for our operations. You will need to familiarise yourself with the regulations relating to this important aspect. Any acts of commission or omission may render you and your organisation liable to prosecution by government or paying out high sums on money in compensation for claims to damage or injuries.

The UK has a set of regulations that are considered very important and are applicable within warehouse operations in the UK as discussed below:-

The Health and Safety at Work Act 1974 (HASWA) is very wide in its scope and places responsibility for the health and safety of workers into three categories, namely:

- The employer, whose prime responsibility is to maintain the health, safety and welfare of all employees and visitors to their premises. This includes the provision of a statement of their health and safety policy, the training of staff and the provision of any necessary protective equipment

- The employees, who have an obligation to co-operate with their employer in all health and safety aspects, to undertake the training provided and to properly use any equipment provided for safety purposes. Further, employees are expected to report any unsafe practices and not to endanger any other person by their own acts or omissions
- Manufacturers, who have to ensure that their products are safe to use under normal circumstances, in the environment they were designed for, and are fit for their purpose

Every person working in a warehouse needs to be aware of their obligations under HASWA. We need to be aware of the supporting approved codes of practices (ACOP) and other regulations that are legally binding and underpin HASWA. These include:

- Management of Health and Safety at Work Regulations 1999, which support warehouse staff in fostering a proactive approach towards building a positive health and safety culture within the organisation
- The Workplace (Health, Safety and Welfare) Regulations 1992, which deal with preventing hazards arising from poor housekeeping
- The Provision and Use of Workplace Equipment Regulations 1998 (PUWER), which require employers to ensure that the equipment provided for use at work complies with the regulations
- The Manual Handling Operations Regulations 1992, which cover all aspects of moving goods by hand
- The Health and Safety (Display Screen Equipment) Regulations 1992, which applies to visual display units (VDU) for computers or microfiche
- The Personal Protective Equipment at Work Regulations (PPE) 1998, which states that employers must provide PPE to employees where there are risks to their health and safety that cannot be controlled by other means
- Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR), which require employers to notify the

Health and Safety Executive of workplace accidents causing more than three days' incapacity, a major injury or a fatality

- The Control of Substances Hazardous to Health Regulations 2002 (COSHH), which require employers to assess the risks to employees working with hazardous substances and to classify, package and provide information on substances listed in the Chemical Hazard Information and Packaging Regulations 1994 (CHIP 1 and 2)
- The Environmental Protection Act 1990 and the Waste Management Licensing Regulations 1994 set out a hierarchy of options for dealing with waste material

In addition to the above, there are a number of laws governing working hours, recruitment and the selection of personnel, which broadly cover equality of opportunity and safeguarding of the rights of the (potential) employee.

Each country has its own set of regulations. In our warehouses, we must carry out a properly planned programme of risk assessments. The purpose of these is to determine what is probable –not what is possible – and assess the potential severity should an incident occur. The risk assessment process requires us to:

- Ensure that assessments are undertaken
- Act upon the findings
- Record our assessments and the action we have taken
- Communicate everything to all employees

We must monitor the control measures introduced as a result of our assessments and review them regularly to ensure that they continue to be effective.

Task 2.9

Describe the most recent health & safety training your company has provided you with.

2.7 The Environment

During the manufacture, storage and transportation of any product, we will generate a number of different waste materials. Again this aspect is regulated in some countries, e.g., in the UK, The Environmental Protection Act 1990 and the Waste Management Licensing Regulations 1994 set out various options for dealing with any waste created. We must comply with any legislations relating to the disposal of waste. .

All industrial or commercial waste, whether hazardous or not, is termed 'controlled waste' and can only be transported and disposed of by authorised and licensed companies. For this reason, we need to consider our site registration and licensing to enable waste to be removed and to establish the authorised companies we use for our waste removal. We all have a duty of care that places responsibility on us for the safe handling, storing, recycling, disposal or transport of controlled waste and for taking all reasonable steps to prevent the escape of waste. This also implies that we must keep adequate records, correctly complete paperwork (waste transfer notes) and maintain an effective audit trail.

There are other potential environmental problems in addition to waste disposal. These are also subject to regulation and may affect our warehousing and transport operations. This concerns pollution and here are some examples:

- Noise
- Vibration
- Visual intrusion

- Exhaust emission
- All types of pollution in air and water

If our site is near residential housing, the approach roads and hours of operation may be a significant factor in how we plan our distribution operation. Neighbours may complain about noise from our vehicles entering or leaving the depot and may also complain about repair work being carried out at unsocial hours.

Complaints from local residents may result in a visit from an enforcing officer, who will decide whether our operation is an intrusion or nuisance. They may measure our activities and this might include the level of noise, smells, ecology, vibration, commuting staff and visual intrusion. The local authority may issue us with an abatement order if it finds that we are a nuisance to the local community and the environment.

Task 2.10

Describe, to the best of your knowledge, how your company relates environmentally to its neighbours.

Task 2.11

The following data relates to the throughput of pallets in our warehouse. Following the introduction of ICT, each pallet's total handling time was reduced by 0.5minutes. The warehouse operates 5 days per week and each operative works a 35 hour week. By how many can the number of operative on this task be reduced?

- *Day 1 = 840, day 2 = 800, day 3 = 880, day 4 = 860, day 5 = 820.*

Task 2.12

Carry out a SWOT analysis on your own position with a view to preparing yourself for a promotion.

3. Warehousing Principles

3.1 Learning Outcomes

By the end of this section you will be able to:

a. Describe why a given organisation's warehouse is located where it is.

b. Calculate the amount of free space in a warehouse in relation to its overall size

c. Describe the pattern of stock flows within a warehouse

d. Compare the various ways in which stock may be separated

e. Describe how stock may be put into units

f. Illustrate a process of stock rotation

g. Demonstrate the right packaging for different goods in a warehouse

3.2 Warehouse Location

The location of a warehouse and its position in the total supply chain is an important factor in relation to our ability to provide customers with the best possible service at the most economic price. Materials handling is inevitably an expensive process when you consider the cost of the people involved and their time, together with any equipment they may use. If our warehouse is planned and located well, it will significantly decrease the cost of our materials handling and consequently of our products. On the other hand, bearing in mind that re-locating a warehouse is only done infrequently, if it is not well located then the adverse effects are going to be a problem to the company for a long time – possibly even a number of years. We should also relate the location of the warehouse to the company business plan, which tells us where we will be in a few years' time. We should include factors such as the quantity and type of product

we are likely to hold, our potential customer base and also any future research and development issues the plan may include.

Some of the main factors that can affect our choice of warehouse location are as follows:

- Proximity to our customers – which will have a major effect on both our delivery transport costs and service levels
- Proximity of our suppliers – this can also affect their service levels to us, as well as the cost of transportation. If they deliver to us, their costs would be built into the price they charge us for their products. However, if we collect from them, these transport costs become ours directly
- Availability of transport networks and associated costs – this is important so that we can select economic routes that suit us and we are not forced to travel any unnecessary distances
- Availability of human resources and skill base – this is critical, as without the ready availability of suitable staff our labour costs could escalate dramatically. Examples of this are when companies compete with each other for staff by offering higher and higher wages, as well as perhaps having to provide a free bus service from a number of local towns or residential areas
- Local planning considerations and incentives – for example, in areas where the availability of work has diminished, local authorities who wish to attract work into their area may offer a rate reduction on premises for a period
- Environmental issues – as we have already seen, waste disposal is an important issue. However, we must also consider our potential for environmental intrusion on our neighbours and the neighbourhood.

Task 3.1

If a company needs to make special arrangements in order to attract the calibre of staff it wishes to employ, give three examples of what they might be.

We need to view the issue of the warehouse site as a whole. Rarely does any site perfectly match our requirements, so a decision must be made concerning what our priorities are and the trade-offs made between them at the planning stage. Other factors we should consider are as follows:

- Type, size and number of products stored – which will determine the size and type of warehouse we need. For example, temperature controlled for chilled or frozen produce, very secure premises for valuable products etc.
- Type of vehicles and the size of their manoeuvring and parking areas. Any loading and unloading restrictions and motorway accessibility.
- Environmental and local authority constraints – proximity of any bridge height or weight restrictions on surrounding and/or approach roads.
- Employees' car parking – a necessity now as the majority of workers travel to work in their own cars. A good solution will avoid any potential congestion caused by parking in surrounding roads.

3.3 Warehouse Utilisation

The most common way we describe a warehouse size is by reference to its area, for example 10,000 square metres, although it is in fact the measure of its total content or space – the cubic capacity, for example 5,000 cubic metres – that is the most important criteria. The majority of warehouse overheads such as rent and rates are based on the square area, so the higher we can make use of the space above the floor, the lower will be our storage standing costs.

It is clear that ‘block stacking’, i.e. stacking the product on itself possibly from floor to ceiling, is going to give us the best utilisation of the ‘cube’. That said, we can only get at the most recent product that was put into the store, which in most cases is not a suitable situation. On the other hand, for us to be able to get at every product as and when required, we would have to leave a lot of space around them all.

Therefore, we must make the correct choice of storage equipment as this will give us efficient use of the ‘cube’ combined with ease of access. Our choice depends on the storage area dimensions, the characteristics of the product, the requirement for access by handling equipment, the frequency of product movement, safety considerations and integration with our ICT.

As an example, when using adjustable pallet racking (APR) for the pallet storage medium, we can only achieve the coverage of the floor area to about 40% due to the number of aisles and gangways we must leave. We cannot then expect to be able to fill every space in the racking with a pallet whilst leaving sufficient flexibility for continual in and out movements to take place. In this example, and using a random location system (see later) with a competent ICT system, the best we could normally expect to achieve would be a figure of around 85% utilisation.

Task 3.2

What size is the area of a warehouse that is 85 metres long and 40 metres wide?

Task 3.3

What is the cubic capacity of a warehouse that is 75 metres long, 35 metres wide and has a useable height of 11 metres?

3.4 Product Flow in the Warehouse

There are many ways to position the elements that make up a warehouse. We should consider our travel paths, material handling equipment (MHE) and order picking when planning the flow of goods, as these will affect the efficiency of the operation and influence the effectiveness of the warehouse. If we make a mistake at the planning stage, it will be very costly to rectify at a later date when we have fixed all our storage media in place.

When designing the layout of our warehouse, we should aim for a product flow through that:

- Makes the best use of the cube
- Minimises movement of goods
- Ensures a smooth flow throughout, from receipt to despatch
- Eliminates travelling against the main flow of the product
- Eliminates double handling
- Ensures adequate speed of access to meet customer service levels

3.4.1 Through Flow

This occurs when the receiving and despatching points are at opposite ends of the building and is favoured when goods are received from an adjacent manufacturing source or when different vehicles are used for the receipt and despatch of product.

The features of through flow designs are:

- External vehicle access is required at both ends of the building

- Internally, all products travel the same distance

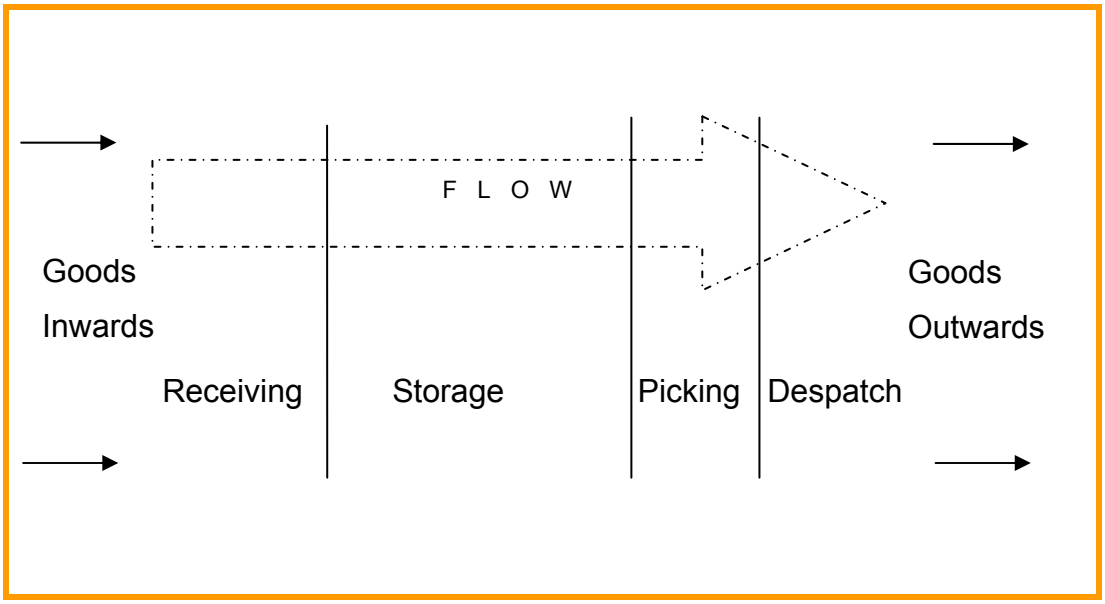

Figure 3.1: Through Flow

3.4.2 'U' Flow

This has the receiving and despatching points adjacent to each other on one side of the building. The features of this type of design are:

- Externally, the building can fit tightly to the site boundaries and/or can be developed on three sides
  - Vehicle parking and access can be shared with easier control and security
- Internally, access points can be utilised for loading or unloading as required
  - Personnel and equipment can be shared between operations
  - Supervisory requirements are reduced
  - Stock movement distances can be minimised by locating the fastest moving products on the shortest routes

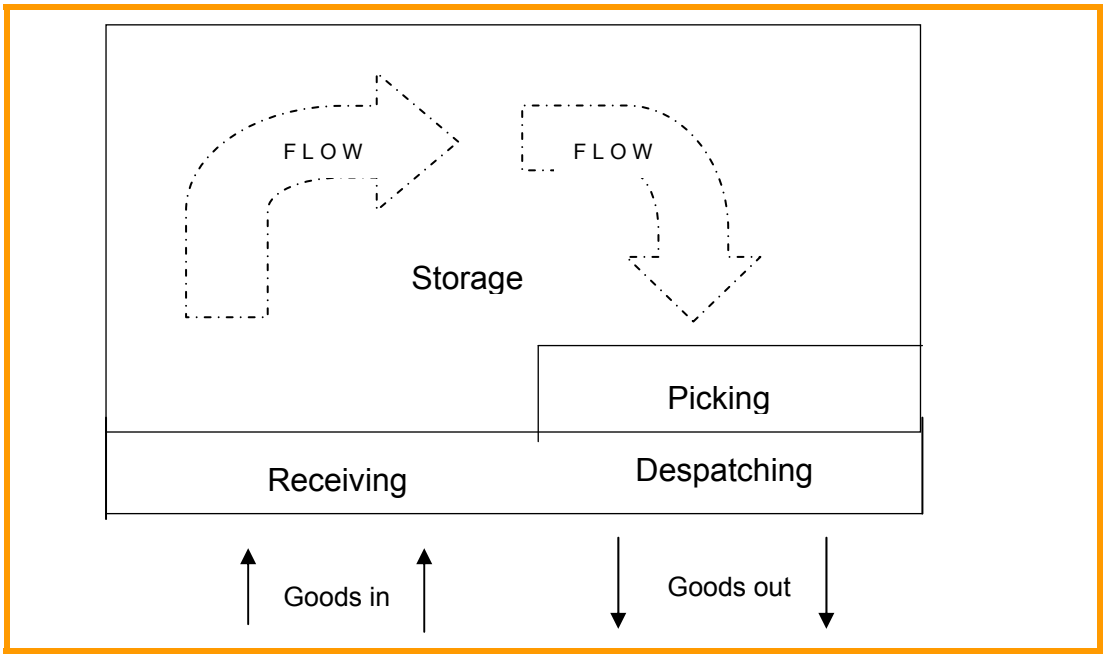

Figure 3.2: 'U' Flow

According to the Chartered Institute of Logistics and Transport publication *The Principles of Warehouse Design*, whichever design or combination of designs is chosen, we should consider the following factors:

- Access to stock for input/output and checking movements
- Balanced traffic flow patterns
- Minimal travel distances for stock movements
- The systematic identification of stock locations
- Grouping of products with similar storage characteristics

Task 3.4

Describe a warehouse and identify its product flow patterns (you might find it useful to use a drawing for this activity).

3.5 Product Segregation

When we consider the storage characteristics of our products, we may have to segregate some items completely from others, for example the handling, storage and identification of hazardous goods. If our product range includes items that require an ambient, chilled or frozen environment they will need to be stored separately. We may also be able to store some goods outside, for example some DIY and gardening products such as plastic piping. In this case, we would have to consider the need for lighting and access.

In addition to their storage requirements, there are other product features that will determine whether we need to assign specific areas of the warehouse for:

- Binning for small parts or semi-bulk items, for example nuts and bolts
- Extra large space for heavy and awkwardly sized or shaped items such as rolls of carpet, vehicle body parts and windscreens
- Secure storage for high value or security items such as jewellery or confidential paperwork and records
- Carefully controlled storage and access methods for fragile stock such as glassware, crockery and so on

Unfortunately, some of these considerations that determine where and how we store these items may sometimes be in conflict with our ideal warehouse flow pattern. In extreme cases, it may even be necessary for us to consider the requirement for us to use an alternative storage location – namely, contracted, remote or 'outside' storage.

Task 3.5

Identify three products that might be stored in a warehouse that have to be segregated and why this would be necessary.

3.6 Unitisation

Individual items of a similar nature can be assembled into a ‘unit load’ that has defined dimensions and weight. This unit load can be defined by us, our customer or our even our suppliers. Once we have assembled a unit load, we can then handle it without separating it into its constituent parts again. Examples of unit loads being created include the following:

- A manufacturer who stacks each of his finished products separately onto pallets, which are then put into store or onto vehicles for delivery to his customers
- A distribution warehouse where customer orders are picked into roll cages for delivery
- Tote boxes are also often used to collate customers’ orders of small items such as 2 or 3 toothbrushes, a few bars of soap and so on.

The benefits that can be obtained through the creation and movement of unit loads include the following:

- They create the ability to move large quantities of goods per journey, so minimising the number of journeys
- It is easier for us to automate materials handling and allows the use of standard handling and storage equipment, for example UK pallets, International Standards Organisation (ISO) containers etc.
- Unit loads assist us to make better use of the storage cube
- They make it easier for us to load and unload vehicles and to move stock into, around and out of the building
- Unit loads can be designed that give greater security and protection to our stock

Task 3.6

Give two examples where companies commonly make use of the principles of unitisation.

3.7 Stock Rotation

When we plan materials handling, it is necessary to have a working knowledge of the profile and rotation requirements of the stock we are likely to hold.

The majority of products will have a predetermined and limited lifetime, so we normally need to ensure that we use the oldest first. This means that we will need a controlled 'rotation' procedure for the stock in our warehouse. Ideally, this will ensure that the 'First in is first out' (FIFO). The opposite of this is 'Last in first out' (LIFO). We may rotate our various products by reference to the date of their receipt, their pre-determined shelf life, or by their batch or serial number. It is important, therefore, that when we retrieve stock from storage we have a procedure that ensures the oldest stock is removed first.

We may not need to carry out stock rotation when the turnover of a product is extremely fast or if the warehouse is a transhipment area where all goods received are despatched without further processing. However, when there are rotational requirements, we must ensure they are strictly adhered to.

Task 3.7

Give three examples of how the rotational requirements of a manufactured food product may be determined.

Task 3.8

Do rotational procedures apply equally to all products, or do some of them have different requirements? If so, explain the differences.

3.8 Packaging

The following is a definition of packaging provided by the British Standards Institution (BSI):

“Packaging is a means of ensuring the safe delivery of a product to the consumer in sound condition and at minimum cost.”

Packaging is an important consideration in any supply chain and the design and use of packaging impact not only on storage and handling but also on other functions such as production and marketing. Packaging fulfils the following functions:

- To protect and preserve a product or the environment from physical, chemical and mechanical damage, deterioration or contamination
- To facilitate ease of handling
- To communicate information, for example safety instructions
- To act as a marketing aid, through appearance and presentation
- To facilitate ease of storage

In addition to protecting products, packages should be easy to handle, convenient to store, readily identifiable, secure and of a shape that makes the best use of space. There are trade-offs between these factors that will concern the product and the materials handling process. For example, the packing required to best protect an awkwardly shaped item may have to be balanced against the optimum shape for either handling or space utilisation. We must realise that product packaging should assist handling, rather than hinder it.

Items may be delivered to us in bulk by our suppliers and some of these will need to be 'broken down' into manageable pack sizes to meet the requirements of our customers. Indeed, some customers may require a product delivered as an individual item and in these circumstances, additional packaging is required for transit.

Certain hazardous materials require extensive packaging in storage and in transit, and we must be aware of the requirements that are contained in the regulations. Certainly, European law requires that the movement of dangerous goods must be supervised by a qualified person – a Dangerous Goods Safety Advisor (DGSA).

The UK legislation applicable to packaging is the Packaging Waste Regulations 1997 (this regulation is enacted under the Environment Act 1995). It applies to companies that make, fill or sell more than 50 tonnes of packaging per year, and requires them to recover and recycle specified percentages of packaging

Task 3.9

Does your company, or one that you are familiar with, use additional packaging during its materials handling processes? If so, explain the reasons for this.

Task 3.10

We have a warehouse that is 300 metres long and 50 metres wide.

Our racking covers a total area of 6000 square metres.

What is our percentage utilisation of the total warehouse area?

Task 3.11

We have a warehouse that has a total capacity of 25000 pallets. At the beginning of a week, we had 22000 pallets in store.

During the week, no goods were received and there was a steady outflow of 2000 pallets, leaving 20000 pallets in store at the end of the week.

What was our average pallet location utilisation percentage that week?

4. Storage and Materials Handling

4.1 Learning Outcomes

By the end of this section you will be able to:

a. Describe the types of storage systems in a warehouse

b. Explain the location numbering systems used in a warehouse

c. Illustrate the storing strategies in use in a warehouse

d. Illustrate the types of Mechanical Handling Equipment (MHE) used in a warehouse

e. Explain why automatic systems may be used in a warehouse

4.2 Storage Equipment

All warehousing systems are a compromise between the efficient use of warehouse space and easy access to the goods. Some warehouse storage systems (e.g. high bay, narrow aisle racking systems) require planning in the warehouse design stage and can take many months to come into operation.

Guidance notes for the use of storage equipment can be found in various codes of practice, occasionally published by the Storage Equipment Manufacturers' Association (SEMA). Whenever we are planning to introduce storage equipment, there are several principles we should consider:

- Goods – type, accessibility considering frequency of movement/picking and stock rotation requirements
- The effective use of the ‘cube’ verses stock accessibility
- Unit size – capacity, stability and stack-ability of the product, for example pallets, cartons
- Handling equipment available or to be selected – type, maximum lifting height, overall dimensions and aisle width

- Storage area dimensions – floor loading capacity, obstructions, entrances/exits and floor fixing facilities
- Safety – fire protection requirements, fire exits and personnel health and safety
- Overall system cost and integration with our current or future ICT

Consideration of the above principles will enable us to select the storage method(s) and equipment most suited to our specific needs. There are many manufacturers that supply storage media and, generally, their equipment has been designed to meet the widest range of requirements. Storage equipment does not, therefore, have to be custom-built; however, we do need to appreciate all the various issues involved so that we can obtain equipment that provides us with the best utilisation of our space at the lowest cost to us.

The more complex the system is that we choose, the less flexible it may become in the future and it may not be possible to either adapt it or sell it. It is important, therefore, that our initial cost-benefit analysis should take into consideration the life expectancy of our systems.

Task 4.1

Considering the storage media in a warehouse you are familiar with, do you think it is well suited to the products stored and does it make good use of the cube?

4.2.1 Aisle widths

With all types of storage systems, particularly pallet racking, aisle width is a major consideration as this will have a direct effect on our utilisation of the cube. Aisle widths depend on the overall level of our activity, the products we store and the speed of access we require. If we are only bulk

picking full pallets, then we could have a very narrow aisle system using specialist narrow equipment, which would give us a very high density of storage. Nevertheless, if we are manually picking customer orders, then our aisles will need to be wider in order to prevent bottlenecks and to facilitate replenishment activities.

Task 4.2

Do the aisle widths in a warehouse you are familiar with suit the operation concerned, or would you make any changes?

Our choice of storage method and equipment includes the following examples:

4.2.2 Block stacking

It is possible for us to store goods without using any equipment as we sometimes come across goods that can be stacked on top of each other. This may be because of their own in-built strength or because they are packed in containers that can withstand a given amount of weight. The great advantage of block stacking is that our utilisation of the cube could be very high, whereas with pallet racking the maximum might be only 40% or 50%.

Then again, block stacking is not suitable for every operation – even when the goods can be block stacked. For example, if we are required to send goods out in a strict First In, First Out sequence, we are going to be faced with an accessibility problem as we would have to take the stack to pieces to get at the oldest stock. That said, *block stacking is highly cost effective and we should use it whenever we can.*

Task 4.3

Is block stacking used in a warehouse you are familiar with? If so, is it used for all products? If not, why?

4.2.3 Post and cage pallets

Some of our goods and their packaging may be sufficiently strong to withstand the weight of other goods above them, but their shape means that if we block stack them it would be dangerous because the stack would be unstable. Other goods may be incapable of being block stacked because they would be crushed. We can get around these two problems by using post pallets or cage pallets.

These methods are effective because the weight is taken not by the goods but by the pallet itself, as it consists of a pallet with an upright post or pillar at each corner. Additionally, as the feet of the pallet above fit onto the tops of the columns of the pallet underneath, they are quite stable and can be stacked to a considerable height.

With cage pallets, the four sides are covered by a strong mesh and we tend to use these for irregularly shaped goods that are likely to be unstable.

4.2.4 Drive-in/ Drive-through racking

Installations of this type are the nearest to block stacking, as the supporting uprights and beams take up little space between the pallets. The pallets are stored in a series of tunnels, one above the other, and the handling equipment drives along the ground floor tunnel. Each tunnel at each level contains a pair of beams, rather like railway lines, onto which our MHE operator places the pallets.

4.2.5 Adjustable Pallet Racking (APR)

Most pallets are made of wood, although they can be made of steel, aluminium or plastic. There are two basic types – the two-way entry where the pallet can be picked up from the front or the back, and the four-way entry where it can be picked up from the sides as well.

Pallet racking needs to be able to support the pallets and still allow access for the MHE we use to put away and retrieve the pallets. To achieve this, the racking consists of beams that are supported by upright end frames bolted to the floor. These end frames are perforated to allow the position of the beams to be adjusted upwards or downwards so that we can vary the height/size of the locations. The beams themselves come in a variety of lengths and load carrying capacities and we should match these to our products' weights and dimensions.

Although pallet racking is adjustable, this facility is much less used than we might think. Our location sizes will probably suffice for a number of years because the design of our unit load, once established, will continue almost indefinitely.

Nonetheless, we may wish to increase our warehouse pallet capacity by adding more racking, and one way we can do this is by reducing the width of our aisles. *Wide aisle racking systems are installed where we use a counterbalanced forklift truck to get access to the products in the racks*. This type of truck needs considerable space to manoeuvre and a typical wide aisle might measure 3 or 3.5 m. *If we reduce the width of our aisles, we will need to use a different sort of truck called a reach truck*. These can have the same lifting capacity as a counterbalanced truck but require less aisle space – typically around 2.5m. In fact, it is possible to get the aisle width down to 1 m or less by using increasingly more specialised equipment.

Because of its flexibility and the ease with which we can handle palletised loads, pallet racking is one of the most widespread types of storage

medium and we are likely to come across it in nearly every warehouse of any size.

Task 4.4

Explain the benefits of an APR system.

4.2.6 Narrow aisle racking

This racking is of a similar construction style to APR but tends to be heavier and stronger in order to take greater weights to greater heights. It is where we use the narrowest handling equipment in order to have the narrowest possible aisles, which in turn gives us the best possible utilisation of our floor space. With the very stable specialist handling equipment available, this type of installation also gives us the opportunity to make the best use of the available height.

4.2.7 Live racking

A live rack is one where we allow the goods themselves to move within the rack, usually under the power of gravity. An installation of this type consists of a rack in which the load support beams have been replaced with a framework containing rollers set at an angle, sloping down towards the front of the rack. Because there is movement involved, this sort of installation is only suitable for goods that are packed in such a way that we can place them onto the rollers without any chance of them becoming jammed or spilling the contents. This means that palletised goods are ideal for this type of installation.

Any goods we place into the back of a live rack will move forward down the slope until they reach a stop at the front of the rack. When the first item is removed from the front, the remaining items will again move

downwards, which means that the next item to be retrieved is always presented at the front of each row. One of the advantages of this system is that the goods are always presented for retrieval in the same order in which we loaded them into the back of the rack. In other words, this system will ensure we adhere strictly to a policy of FIFO.

Task 4.5

Explain the benefits of a live racking installation.

4.2.8 Mobile racking

In a mobile racking installation, we mount the racking on rails and move it backwards and forwards across the warehouse floor. We can do this with any type of storage medium, whether it is pallets, shelves, or bins. We would start off with a number of racks all pushed up close to each other but in this way we could not access any of the locations. By parting the racks at one point, we will have created an access aisle for those locations. The great advantage is that we have reduced the number of our aisles to just one and we gain access to each of the racks by opening them and creating an aisle at the appropriate place.

Still, we must be aware of one huge disadvantage with mobile racking – it can be very slow to operate and use. There is a good reason for this as each rack may be very heavy when loaded and several racks may need to be moved to gain access to the one we want. Even in smaller installations where several racks can be moved at a time, there will always be a delay while we open the correct aisle.

4.2.9 Cantilever racking

Cantilever racking is designed specifically to store long goods. It consists of a row of upright pillars from which protrude a number of arms, and we

store the goods by resting them on these arms. This type of racking is useful for storing things like carpets, timber, pipes made of steel or plastic, metal rods and bars and ladders.

A variation on cantilever racking is where long goods are stored vertically. Here, the arms do not actually support the goods but simply prevent them from falling over. Installations like these can often be seen in DIY warehouses for storing goods like curtain rails, ladders and small section timber.

4.2.10 Shelving and binning

Most industrial shelving and bin storage systems consist of an enclosed frame into which the shelves or bins are fitted as required. We generally limit the height of each rack to about 2 metres as the majority of this type of installation is used for manual picking. The frames, shelves and bins come in a variety of widths, allowing us to fit them into restricted areas.

Although most shelving is used for manual picking, we can pick from it mechanically by using an order picker which drives between the shelves and lifts the operator up and down to the required height. This has the advantage of allowing us to increase the height of our installation by stacking one rack on top of the other.

The aisle width in a shelving installation can be very narrow. For both mechanical picking and manual picking it can be as little as 1 metre, depending on the width of the MHE we are using.

4.2.11 Carousels

A carousel alters the way products are retrieved from storage. In all the storage methods that we have looked at so far, the storage media and the goods remain in a fixed position and our operator moves around between them. With a carousel, the opposite takes place as the operator stays in the same place and the product comes to them.

The two most usual sorts of carousel are:

4.2.12 Vertical carousels

These consist of a cabinet that contains rows of small bins or shelves that are attached at either end to chains that move up and down over pulleys. As the chain moves, each row of bins is presented in turn to the operator through an opening in the front of the cabinet. The height of a vertical carousel is restricted only by the height of the warehouse and they are, therefore, efficient in terms of their use of the cube. Another advantage of vertical carousels is that they can be locked when not in use. As a consequence, they can be useful for storing small, high value goods such as jewellery or computer memory.

4.2.13 Horizontal carousels

These consist of vertical rows of bins that are suspended from chains that also rotate around pulleys, but in this case the movement is left and right rather than up and down. As the chains move round, each panel of bins is presented in turn to the operator. The height of a horizontal carousel is restricted to about 2 metres as the goods have to be selected manually, but the length of the carousel is restricted only by the length of the warehouse, although most installations are much smaller.

Both these types of carousel offer the advantage of being controllable by a computer. This means that we can dial up/enter the details of the product wanted – the carousel will rotate and stop with the product in front of us – and then all we have to do is select the required quantity.

The main features of some of the different methods of storage are described in the table below:

Feature	Adjustable Pallet Racking	Drive-in Racking	Live Racking (gravity fed)	Narrow Aisle Racking	Block Stacking
Floor space utilisation	30–40%	80%	70%	65%	90-100%
Speed	Very good	Good (one way)	Very good (one way)	Very good	Good (one way)
Stock rotation	Easy	Very good (one way)	Very good (one way)	Easy	Very poor
Stock variability	Easy	Limited	Limited	Easy	Limited
Order picking access	Very good	Limited	Good (one end only)	Very good	Good (one end only)
Equipment	Standard	Standard	Specialised/ standard	'Bespoke'	Standard

Table 4.1: Storage methods key features

Task 4.6

Identify and describe a type of storage method used by your company, or one that you are familiar with.

4.3 Location Numbering Systems

The purpose of location identification systems is for us to know where all our products are and so that we can place stock in, and recover it from, a specific known position.

We must ensure that our location identification system is clear and easy for everyone to understand. To achieve this, we usually use a sequence of alpha-numeric characters, i.e. a combination of letters and numbers. An alpha-numeric-alpha-numeric sequence (for example A17C3) is easier to remember and say, so it is less likely to lead to confusion than an alpha-

alpha-numeric sequence (e.g. AB7) or a numeric-numeric-alpha sequence (45G). The identification allocated to a location is often called its ‘address’ due to its purpose and similarity to a postal address, which is universally understood.

An example of an alpha-numeric-alpha-numeric system and its similarity to a postal address is shown in the following table:

Location address 3 H 21 D 2	
Alpha-Numeric Characters	**Postal address**
3	Zone or town
H	Aisle or street
21	Bay or house
D	Level or floor
2	Position or room

Table 4.2: Alpha-numeric location identification

We can also have completely numeric systems and we would usually prefer to use this kind of system when we have to type the address frequently or quickly.

We would normally prefix the single numbers with a zero to enable our computer, when sorting the locations, to put them into a logical sequence. In these systems, we also use the stops to separate the numbers for each zone, aisle, bay, level and position.

An example of an all numeric system and its similarity to a postal address is shown in the following table:

Location address 03.08.21.04.02	
Numeric-Numeric Characters	**Postal address**
03	Zone or town
08	Aisle or street
21	Bay or house
04	Level or floor
02	Position or room

Table 4.3: Numeric-numeric location identification

Task 4.7

Explain the location identification system used in a warehouse you are familiar with.

4.4 Storage Strategies

We can programme storage rules into our computerised Warehouse Management System (WMS) so that it can allocate locations to all our goods when we key in their receipt at Goods-inwards. Firstly, we must ourselves decide what these rules should be and these decisions will be based on how we want to manage our warehouse space.

In the examples of the location identifications above, the first part of the address refers to the 'zone'. We would create separate zones in our warehouse in order to differentiate between groups of products for a variety of reasons. We do this so that we can ensure that all the products in a zone have similar storage characteristics and requirements. Examples of this are products that are ambient, chilled, frozen, fresh, valuable etc.

Another important characteristic of our products is their popularity, their volume of demand and movement. When we consider our warehouse product flows, we should place our fastest moving products on the shortest route through our warehouse in order to minimise their travel time. Zoning our warehouse enables us to do this.

A further decision we must make is whether to allocate locations to our products on a random or fixed basis. A fixed pallet location system means that we will always allocate the same product to the same location; however, a random location system means that we can place a pallet in any empty location. A fixed pallet location system will only give us about 50% space utilisation, but random pallet locating can provide us with about 85% space utilisation.

The most usual arrangement is for us to have a combination of the two methods. This means that we must decide which locations are to be fixed and which are to be random, and we can do this separately within the various zones of the warehouse. For example, we could use random locations in our bulk or reserve store and fixed locations for each individual product's position in the order assembly area, i.e. its pick face.

Task 4.8

Describe what storage strategy, in terms of storage media and location system, you would choose for a warehouse where individual full pallets of each product are received, stored and despatched quite quickly without being broken down.

4.5 Mechanical Handling Equipment

Warehouse mechanical handling equipment includes that which we use for horizontal and vertical bulk load movements as well as individual item handling and collation. Our primary aim in selecting such equipment should be to find the right balance between:

- Maximising the use of space, whilst minimising the handling and time taken in the operation of the warehouse
- Reducing the unit material handling costs and overheads including capital costs

One of the ways that we can work towards this is to employ the maximum amount of ICT systems available to us in order to control all of our MHE movements so that we minimise travelling distances, times and, ultimately, our costs. We could help to achieve this by fitting all our equipment with Radio Data Terminals (RDT) that can communicate in real time to the mainframe containing all our management programmes.

Further principles that we need to consider when deciding what type of MHE we require include:

- Simplicity, continuous movement and mechanisation improve efficiency – gravity fed systems are cheaper
- Economy is directly proportional to the size of load
- The standardisation of product size or packaging reduces movement costs

Factors that we need to consider when deciding what type of MHE we require include:

- Product stored and unit load to be handled
- Store layout and height, including aisle width
- Building constraints and environmental issues
- Equipment flexibility and cost
- Reliability, efficiency and ergonomics

The correct selection of MHE enables us to ensure that minimal human physical effort is required to achieve relatively large material throughput, thus increasing our efficiency. We need to carefully select our MHE because of its initial high price and ongoing maintenance costs, so we need to make decisions concerning the purchase, rent or leasing, equipment lifecycle and its flexibility. Issues concerning the ongoing use of MHE include whether we use in-house dedicated maintenance engineers or outsource this as part of a leasing contract.

Task 4.9

Describe the three main benefits to be obtained from a well maintained MHE fleet.

There are various types of MHE designed to carry out all movements of products in a range of environments. These include the following:

Pallet movers – the Hand Pallet Truck (HPT) and Powered Pallet Truck (PPT). This is the most basic type of truck and consists of a pair of forks mounted on wheels. We can raise the forks by about 10 cm – just enough to get a pallet off the ground. Once off the ground, the pallet can be moved to where it is required and lowered into position. We can make these movements manually (with HPT) or by using the built-in electric motor (PPT).

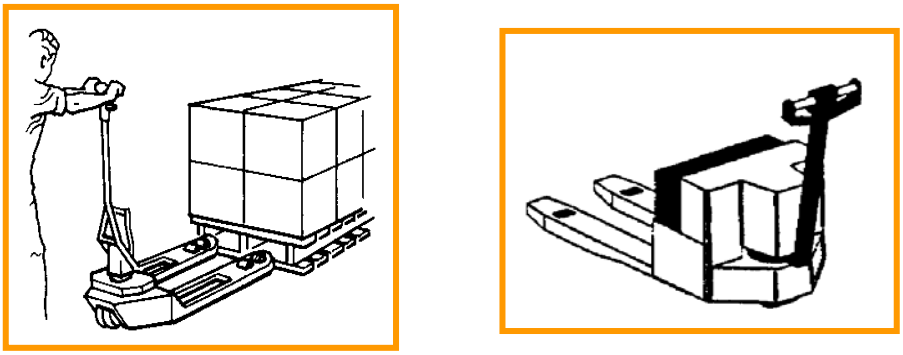

Figure 4.1: Manual and Powered Pallet Trucks

Hand Stacker Trucks – these are small, hydraulically operated forklift trucks that we use for moving relatively small loads. They consist of a wheeled frame holding a pair of forks that we move up and down by using a hand operated pump. We also move the truck itself by hand, towing or pushing it into position. These movements can also be motorised by the addition of electrical motors.

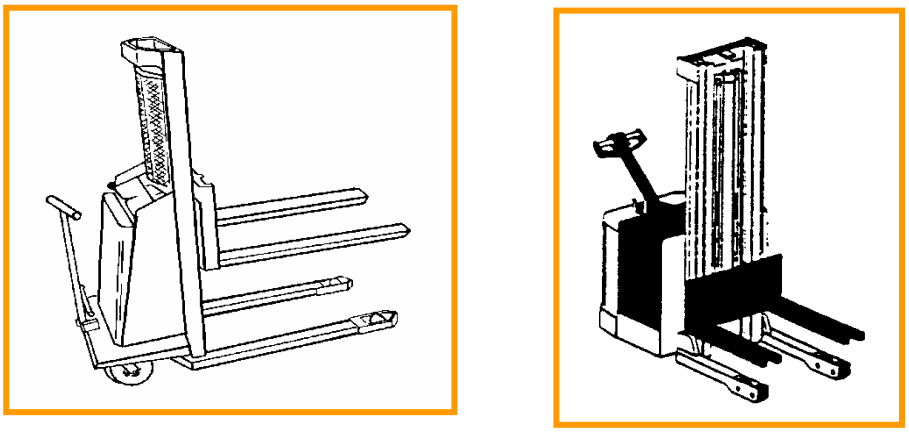

Figure 4.2: Manual and Powered Stacker Trucks

High Level Order Picker (HLOP) – these differ from the previous types of truck we have discussed in that the operator in his cab is raised into the air instead of remaining at ground level. This allows us to pick small quantities of goods at heights that would have been impossible had we remained on the ground. We can use high level order pickers in racking that rises to a height of around 8 metres, above which the truck tends to become unstable.

Some order pickers can be operated automatically by computer. An onboard VDU tells the operator what quantity to pick and the wire-guided truck moves from location to location under the direction of the computer.

Counterbalanced forklift trucks (CBT) – Counterbalanced trucks have their forks mounted at the front end so they have to be driven right up to the load they are to carry. They can vary in size from small units with a capacity of 1 tonne to large machines capable of lifting very heavy loads of 20 tonnes or more. They are the workhorse of the MHE world and, like the hand pallet mover, a version of them – probably with a carrying capacity of 2 – 3 tonnes – is most likely in use in and around virtually every warehouse.

There are two types of counterbalanced trucks – three-wheeled and four-wheeled. The four-wheeled trucks have two wheels at the front and two steering wheels at the back, whilst three-wheeled trucks have two wheels at the front and one steering wheel at the back, meaning that they generally have a smaller turning circle.

Counterbalanced trucks can be operated either by batteries or internal combustion engines, which means that we can use them for working outside in all sorts of weather. Further, they can have either solid or pneumatic tyres, which indicates that they are not as dependent on a smooth working surface as other types of truck.

One of the reasons why the counterbalanced truck is so widely used is that the forks can be replaced with a wide variety of specialised attachments. These might be used to lift such diverse loads as cable reels, drums of oil, bales of cotton and bags of fertiliser, for example.

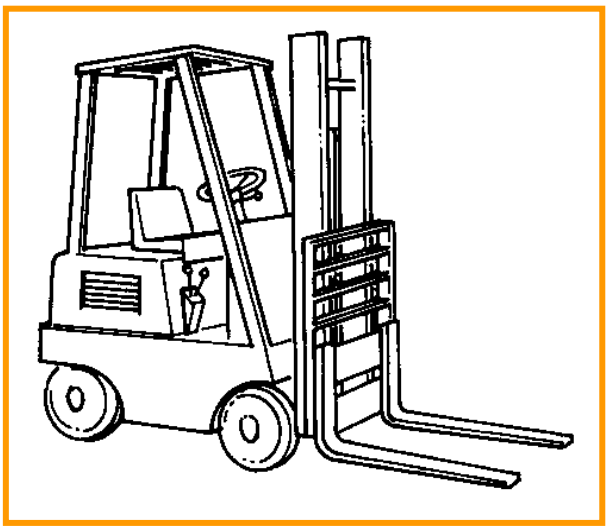

Figure 4.3: Counter Balanced Truck

Reach Trucks (RT) – Reach trucks are the most widely used type of truck for storing pallet goods into racking up to a height of about 13 metres. The difference between a counterbalanced truck and a reach truck is that the reach truck carries its load inside its own wheelbase, while the counterbalanced truck carries the load outside its wheelbase. This makes the reach truck more stable during movements, which makes them ideal for narrow aisle work.

Reach trucks are used mostly inside buildings as their small wheel diameters do not allow them to run on rough surfaces. As a result of this, virtually all reach trucks are battery powered.

Next to the counterbalanced truck, the reach truck is the most commonly used form of MHE and is found in nearly every warehouse where pallet racking is used.

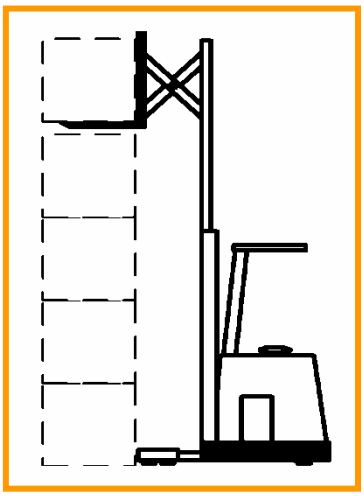

Figure 4.4: Reach Truck

Narrow Aisle Trucks (NAT) and Very Narrow Aisle trucks (VNA) – we use these in racking installations where the racks are spaced so closely together that we cannot use counterbalanced or standard reach trucks. This effectively means an aisle width below about 2 metres. Although this gives us very high density storage, it also means that we need to drive the trucks carefully through the aisle so that we don't damage the racking. For this reason, narrow aisle trucks are almost always remotely steered/ guided. This we can do either by a cable buried in the floor which transmits a signal to the steering mechanism on the truck or by the use of guide rails that prevent the truck from moving from side to side.

As with all of the more advanced types of truck, there are two types – those that lift just the forks and goods and those called turret trucks (TT), which lift both the goods and the operator.

The common principle of NATs, VNAs and TTs is that the truck only moves backwards and forwards and doesn't have to turn whilst working in an aisle. This is achieved as their construction allows their forks to swivel left or right through 180 degrees while the truck itself remains stationary. This means that the aisle can be almost the same width as the truck and still allow a full pallet to be placed into or removed from the racking.

As we have seen, forklift trucks are available in many configurations and the manufacturers of specific equipment will provide details that are accurate and precise. The measurements for the various different types of

MHE described above are listed below in order to give a guide to the key differences:

Type	Maximum capacity	Maximum lift height	Minimum aisle width
Hand Pallet Truck (HPT)	2 tonne	100mm	1.4m
Powered Pallet Truck (PPT)	3 tonne	100mm	1.4m
Counter Balanced Truck (CBT)	3 tonne	7m	2.6m
Reach Truck (RT)	2 tonne	11.5m	2.1m
Turret Truck (TT) & Very Narrow Aisle (VNA)	1.5 tonne	15m	1.35m
High Level Order Picking truck (HLOP)	1.5 tonne	15m	1.35m

Table 4.4: Forklift trucks – typical parameters

Forklift truck maintenance – we need to ensure that a proper plan for maintaining our forklift trucks is in place and this will need to cover the following main points:

- Are brakes, lights, warning devices, safety locks, and overhead guards in a safe working order?
- Are all drivers properly trained and do they attend refresher courses?
- Are FLTs maintained daily, weekly or six-monthly, in accordance with the appropriate checks?
- Are drivers' defect reports completed daily and acted upon?

For example, the following checks are, or would usually be, carried out; however, these are given as a guideline only as the specific FLT manufacturer's schedule must be adhered to.

4.5.1 Daily checks

At the start of each shift, the driver should make the following checks – ticking these off as satisfactory or recording defect information on the check sheet. The driver must check that:

- Tyre pressures are correct and advise on any tyre damage
- All brakes, lights and audible signals operate correctly
- All fluid levels are correct (fuel, water, lubricating oil, hydraulic and engine oil)
- Batteries, where appropriate, are adequately charged and the electrolyte level is checked
- Lifting and tilting systems are operating correctly

Following the checking procedure, the signed check sheet is to be kept on file to provide an audit trail – particularly if a fault needs to be actioned.

4.5.2 Weekly checks (or 50 hours)

A competent supervisor or the maintenance department should make the following checks:

- All daily checks, as above
- The operation of steering, lifting gear and other working parts
- Condition of the mast, fork, attachments and lifting mechanisms
- Check hydraulic pipes for leaks or damage

Again, the check sheet is completed and filed for audit trail purposes.

4.5.3 Six-monthly checks (or 1,000 hours)

A competent person from the maintenance department should make the following checks:

- All daily and weekly checks, as above
- All working parts

At the end of this check, a certificate is completed and filed for audit purposes.

4.6 Automatic Systems

We have already considered the use of ICT systems in an attempt to make our warehousing processes as efficient as possible. The ultimate in this direction is a situation where there are no people working in our warehouse – which would therefore need to be fully automated and mechanised. In this type of warehouse, products once unloaded are put away, stored, selected and despatched by computer instructions. This enables the warehouse to have lower running costs with no lighting or heating, and, as humans have not handled the product, it has the potential to be 100% accurate, 100% of the time. This means that we can possibly offset our initial high set-up costs against the benefits of low running costs. However, this type of installation is very expensive to install and once built is very inflexible, so its useful life should be taken into consideration very early in the planning process.

A more usual approach is to aim to create a 'paperless' warehouse so that our operatives carry out their various tasks as dictated by our WMS, via a RDT on their MHE. Our WMS will be programmed to ensure that these are prioritised according to the needs of the business. Our warehouse may be large enough or we may stock sufficiently small items to warrant the installation of automated picking, storage or movement equipment.

We can facilitate all these systems by using bar coding applications and reading technology. A further advance in product identification that is available to us is RFID, which stands for Radio Frequency Identification. A hand-held device is used to read information contained in a remote chip placed somewhere in or on the product.

Task 4.10

Do you believe that there is the potential for further merchandising and/or automating a warehouse you are familiar with? If so, give the details.

Task 4.11

Describe the storage media and strategies you would be most likely to select for an operation that:

a. Has a wide range of fragile products that it receives with one product per pallet in quite small quantities, as the products have a relatively short shelf life.

b. Prepares its customers' orders for delivery by collating the products onto pallets on an individual case basis.

c. Has a comprehensive WMS system, which is necessary because there is little spare space in the warehouse.

Task 4.12

What MHE would you select for the Goods-inwards section of an operation where full pallets weighing one tonne were received and:

a. Half of the goods arrive on curtain-sided vehicles that have to be unloaded outside in the yard and transferred into the warehouse?

b. Half of the goods arrive in box vehicles that are unloaded through their rear doors over a dock-levelling device directly into the warehouse?

5. Warehousing Processes

5.1 Learning Outcomes

By the end of this section you will be able to:

a. The process of receiving goods into the warehouse and booking them into stock

b. Demonstrate how to locate goods in the correct storage locations

c. Demonstrate how to pick goods against customer orders

d. Demonstrate how to prepare goods for delivery to the customer

e. Perform housekeeping processes

f. Perform stocktaking

g. Demonstrate the use of ICT in a warehouse

5.2 Receipts

On arrival of a delivery to our warehouse, we should carry out checking procedures to ensure the goods received are for us, that they meet our purchase order requirements and are in the correct quantity and condition.

It is likely that we will have advance notification of the expected arrival times of deliveries via our transport management or our suppliers. This should enable us to view a copy of the purchase order details so the above checks can be carried out. Alternatively, arrivals may just turn up

with their delivery or consignment notes and these documents are then used for the checks that are part of the receipts procedure. Unless we have a policy of refusing any deliveries not previously booked in, this is a common way of checking goods in.

Any variances we identify during the checking procedures should be recorded, and notification given to both the driver and our department who raised the initial purchase order. We may then have to isolate (quarantine) the product whilst an investigation is carried out. The department concerned will advise and carry out any reconciliation with the supplier and our stock control system. Once they have completed these procedures, the goods can be booked into stock, taken out of quarantine, and then they can be put away into storage.

Task 5.1

Describe the booking in (diary) system that is used for receiving goods in your warehouse, or one that you are familiar with.

Other activities that may impact on our receipts procedures are, for example:

- Unloading, e.g. hazardous materials, outsized or awkward items may be checked in another part of the warehouse
- Quality control systems may segregate items for a period of time
- Re-palletising or packaging of a product
- Acceptance and checking of returned goods

We should not forget that the prime objective of receipts is to unload the vehicle, check the goods and make the goods available for issue as quickly and efficiently as possible.

The receipts process is a very important element of our warehouse operation – particularly from a quality control point of view. Any errors we make during the receipts process become built into our stock records right at the beginning and will inevitably cause problems later on for any stock reconciliations. Another important point is that any goods received late in the day, and not booked onto our computer system until the following day, add one day to the supplier's lead time of the product as far as the system is aware – it did not know the goods arrived yesterday. Therefore, the stock control computer system will automatically adjust buffer/safety stock levels to take into account the extra day.

As part of our receipts process, additional packaging or preservation may be required as some products may deteriorate whilst in storage. Packaging, apart from its primary function of protecting goods in transit, also assists in preservation. The receipts process may also add packaging as protection for goods whilst in storage.

Task 5.2

Describe how the received goods are entered into the files/records of your warehouse, or one that you are familiar with.

5.3 Putaway

When the checks on a consignment have been completed and we are satisfied that everything is correct, we can enter the goods into our WMS system. This will then allocate appropriate storage locations and we can put the goods away. Putaway means that we collect the goods from the receipts area and take them to their designated locations. With a manual system of putaway there is a possibility of stock being placed in the wrong location owing to human error. With RDTs and bar code readers, the system requires us to input a location check digit before it will allow us to move onto the next job. These check digits are normally clearly displayed

at the front of each location. This system is not 100% foolproof, but it does greatly reduce the number of errors.

Task 5.3

Describe how an operative knows that he has put away a product in the correct location in your warehouse, or one that you are familiar with.

5.4 Storage

Storage involves our stock being put away and held in bulk reserve locations until required for supplying to our customers. This may be in bulk-full pallet quantities or via its pick face where individual items can be selected.

We have seen that our storage areas will need some type of system to determine the location of goods in our warehouse and that this will use either fixed or random locations. Whilst our WMS will quickly determine the most appropriate location to use, it can only do this by using the parameters we have set. This will involve us finding the optimum balance between maximising the utilisation of space and minimising time spent on the various tasks. Determining product location by an ABC analysis, customer speed of response, or as a fast moving item can be useful.

As issues from bulk reserve locations are required, the WMS will notify retrieval activities via the RDTs on our forklift trucks to move items to wherever they are required. For the pick faces this is the activity called ‘replenishment’ (often abbreviated to ‘replen’), which maintains stock availability for order preparation and is important for achieving high levels of throughput and customer service.

Task 5.4

Describe how a 'replen' activity is generated and carried out in your warehouse, or one that you are familiar with.

5.5 Picking

A summary of the tasks concerned with order picking activities includes:

- Collecting picking documents
- Collecting equipment for the picking task
- Locating the picking face and using the check digit (if ICT/bar code system is used)
- Picking and checking the appropriate quantity
- Travelling to subsequent picking faces
- Advising the supervisor of discrepancies/damaged goods
- Travelling to sorting, consolidation, packing and despatch area
- Advising the supervisor of replenishment requirements if necessary
- Completing and passing on documentation (if a manual system is used)

Task 5.5

Summarise the tasks concerned with the picking operation in your warehouse, or one that you are familiar with.

It is clear, therefore, that our picking activities are very varied and often the most important within our warehouse in terms of cost and the level of

customer service. Order assembly systems include taking the 'picker to the goods', where we move along the aisles selecting items as indicated on a pick list. Alternatively, it may involve taking the 'goods to the picker', where the goods move along a conveyer or via a carousel system to the person making the selection. Whatever method is used, our aim should be to find the best possible balance between maximising the access to the goods and minimising the travelling distance and time spent on the operation. To achieve this, there are some basic principles that should always be considered:

- Speed and accuracy (efficiency)
- Layout and equipment required (effectiveness)

Task 5.6

Is the picking system 'picker-to-goods' or 'goods-to-picker' in your warehouse, or one that you are familiar with?

Speed – when considering speed, the two main components are the distance we have to travel and the ease of access to the goods. The closer together the most popular lines are located, the shorter will be the travel distances, but in a busy warehouse this can lead to congestion, which is counterproductive.

Accuracy – simplicity of our paperwork is a key factor here, as is clear identification of the product. Some WMS systems not only give pickers the quantity required, but after they have confirmed that they have picked that quantity will ask them to count the stock remaining in the location – if the quantities do not reconcile, the system will demand supervisory intervention before continuing.

Layout – the first consideration concerning layout is whether the picker should go to the goods or the goods go to the picker – or indeed a combination of the two systems.

'Goods to picker' involves the use of additional equipment such as carousels, conveyors and so on.

The most common method utilised for 'Picker to goods' is where we transfer items from one pallet to another at ground floor level. It is important that we give consideration to planning our 'journey' whilst collating an order, and the two main alternatives open to us are:

The 'U' path method where we travel along an aisle picking from the locations on just one side before turning at the end of the aisle and coming back down, picking from those on the opposite side – therefore travelling in a U-shape within the aisle.

The Snake path method when we move from side to side whilst travelling along an aisle – transferring to the next aisle at the far end.

Whichever method we choose, it is important that our 'Picking List' is printed in a sequence that matches our travel plan in order not to waste time just sorting out the paperwork.

Task 5.7

How would you describe the picking path pattern in your warehouse, or one that you are familiar with?

Another critical factor we should consider is our travelling distance and time between picks. A person can walk about 60 metres a minute but walking with a pallet truck reduces this to about 30 metres a minute. Riding on a forklift truck or picking truck, the travel speed is about 120 metres a minute. These differences soon add up and a picker walking with a pallet truck can easily walk 6–7 miles per day. So, if we can pick 150

pieces per hour and we take four extra steps for each item picked, the extra travel is 12000 feet (about two miles) per shift. The picking of products should therefore take place in a planned and orderly sequence.

5.6 Despatch

As we have seen, part of our order picking activities includes taking the picked orders to a collation point and this should be as near as possible to the despatching point. We can place them in numbered lanes or line them up and prepare them as required for specific delivery routes. It is possible for our WMS to organise order assembly and collation operations so that completed orders are delivered to the despatch area, not only according to their priority of delivery, but also ready to be loaded in the correct sequence for order drop-off. This may include the printing, if necessary, of delivery or consignment notes. It is also possible for the WMS to identify vehicles' body types and sizes for particular routes and plan their loads accordingly. With the use of bar coding and/or RFID and/or GPS combined with ICT, we can track despatch and delivery activities in real time without any requirement for paper records.

Task 5.8

Describe the collation system used prior to despatching customer orders in your warehouse, or one that you are familiar with.

Quality and quantity checks will need to be carried out before allowing goods to leave the warehouse and be booked out from the WMS. This can mean that goods are held in the despatch area whilst these activities are carried out. Care should be taken, therefore, to plan deliveries, the checking and subsequent loading and despatch in order to prevent congestion and to ensure a smooth workload and flow in operations.

As with the goods received area, our goods despatch area is always at risk of congestion, so we must have sufficient loading bays to handle our volumes and the space allocated for vehicle manoeuvring and marshalling areas. Our control of the waiting vehicles and trailers is most important – hold-ups caused for whatever reason, e.g. shortage of the right sized trailers or several vehicles leaving at the same time, can quickly lead to congestion. Bearing in mind that the picking operation will continue to put completed orders into the despatch area, it is essential to keep this operation flowing smoothly if it is not to have a negative impact on our customer service levels.

5.7 Housekeeping

Although the name appears to be the same, we should not confuse this housekeeping with the physical cleanliness of the warehouse – although of course this is also important and does contribute to the general wellbeing and operation of the warehouse.

In our warehouse, our housekeeping processes ensure that all the various functions within our building operate effectively and that stock is available to us when and from where it is required – importantly, this includes our picking locations.

Our housekeeping staff will carry out tasks that add value to our other functions or to the product itself by preventing loss through unnecessary waste. These jobs may include product inspection, identification, and possibly also repackaging.

Some examples of our housekeeping activities are:

- The provision, allocation and maintenance of Material Handling Equipment (MHE)
- Dealing promptly with non-conforming, lost or found stock
- Integrity of stock location records following receipts and putaway
- Re-stocking of fast pick areas from reserves

- Security of high value or hazardous stock

Other issues concerning the efficient and effective use of good housekeeping principles could include:

- Identification of non-moving stock
- Space utilisation and zoning
- Work flow and congestion
- Staffing levels for each area

It is important that our staff throughout our warehouse have a responsibility for the correct and appropriate identification, handling and storage of our products. It is all too easy for us to process goods without any consideration for the next user. It is important that our staff are motivated, enthusiastic and trained to rectify faults in the quality, condition or location of a product when these faults are first noticed, and not to ignore these problems. This culture of total quality in all processes assists in resolving problems early rather than after the customer has made a complaint.

It is the way in which these issues are dealt with, rather than the issues themselves, that is important. Relatively minor improvements to these issues can add value to the whole process and to the efficient running of the warehouse, and it is this overall view which is important.

Task 5.9

Describe the housekeeping activities carried out in your warehouse, or one that you are familiar with.

5.8 Stocktaking

In a perfectly organised and run warehouse, with minimum human involvement and with the comprehensive use of ICT, there should be no need for us to check that our physical stocks match our book stock quantities. We could assume that all the items we have received and that have been located by our computer system are where the computer thinks they are. In reality, although there are warehouses where unloading, bar code reading for receipt and putaway are automated through the use of computers and Automated Remote Vehicles (ARVs), these warehouses are very costly and quite rare.

Our warehouses generally have a mixture of human and mechanical operations and whilst we may make every effort to control the total quality of our warehouse processes, humans are not infallible. Mistakes can be made in counting and locating the product, and machinery may damage the goods. When these issues are combined with a paper-based system within which the processes and procedures are not always strictly adhered to, it is necessary – at least once a year – to account for our product within the warehouse by stocktaking/counting. In some cases, it is a legal requirement to do so as the value of the stock forms part of the published annual accounts.

Traditionally, the checking of stock meant a complete shutdown of our warehouse operation and many staff would be required to assist in the counting of all the items. This could take some days, if not weeks, for our stocktaking team to prepare, which would be followed by the reconciliation of physical stock actually counted to the book records. However, with today's climate needing and demanding time compression, particularly in the area of customer response and service, it is not usually possible to close our warehouse operation completely without detriment to our customer service levels.

As stocktaking is a necessity, it can best be carried out using the perpetual (cyclical) method. This method is based on reconciling a relatively small proportion of our stocks on a more frequent basis – probably daily or weekly. For example, if we were to stocktake just under 8% of our total stock every week, we would have checked all of our stock 4 times during

that year. This can be demonstrated by the following calculation as 7.69% x 52 weeks = 400% i.e. 4 x 100%.

We can apply this method in one of two ways:

Method 1 – we could check a number of stock lines by printing a list of the items we wanted to check and their respective locations, which we could then examine and verify that the details were correct. The disadvantages of this method are that if on examination of a location it contains the wrong stock, there is no indication of where the 'lost' stock might be – with a random location system, the stock will be scattered all over our warehouse.

Method 2 – we could check a proportion of the total number of locations in our warehouse. This we could do by printing a list in location sequence showing the contents of each one. By verifying each location's contents, we are verifying the accuracy of our stock records – products and locations. The advantages to us of using this method are that it is quicker to carry out, as only a small part of the warehouse has to be travelled, and stock seen in a location that is shown as empty on the list is 'found' stock. A further advantage of this method is that only a small proportion of the warehouse has to have access restricted for safety reasons.

If the level of accuracy of our stock records is acceptably high, this can mean that the records themselves may be used to arrive at the annual stock valuation without additional stocktaking.

However, we should all be aware that any stocktaking is only a snapshot of the product at that moment of time, and that whenever and wherever humans interact with the product then the potential for shrinkage (theft) and breakages may occur. Stock reconciliations, unfortunately, are rarely 100% accurate.

Task 5.10

Describe the stocktaking processes that take place in your warehouse, or one that you are familiar with.

5.9 Computerised Systems

We have already seen how important it is that our warehouse is as efficient as possible in all its various operational elements. That said, a potential danger of concentrating on efficiency is that we may lose sight of the fact that in order to continue to meet our customers' –- probably ever-changing – demand profile, we must also be as flexible as possible. This we can achieve by carefully designing and making use of modern technology through Information & Communication Technology (ICT) systems such as Electronic Data Interchange (EDI), Warehouse Management Systems (WMS), Inventory Management Systems (IMS) and warehouse Automated Remote Vehicle (ARV) guidance systems. Paperless systems allow data/information/instructions to be adjusted and brought up to date at the last minute – a clear advantage over paper-based systems where this is more difficult and time consuming.

Another important contribution that ICT makes is that it enables us to measure performance levels throughout our warehouse by department and team, as well as individual operatives and units of machinery. This in turn allows us to recognise, and hopefully solve, any problems that occur, thus highlighting where we can make savings and/or take remedial action.

ICT enables us to make decisions that effectively and efficiently co-ordinate and use the whole capacity of the supply chain, consequently fully utilising all the resources available. For example, if in our warehouse we move to a real time paperless stock control and order picking system using radio data terminals (RDT) mounted on forklift trucks and hand-held bar code readers, this will speed up the processes of receipt, order-picking and dispatch. This in turn will help to reduce costs whilst at the same time

speeding up delivery to our customers – which means keeping customer service levels as high as possible.

We must not forget, however, that developing and installing ICT systems such as these usually incurs high start-up costs, and implementing such a system can take many months, if not years. We should always carry out a comprehensive and detailed cost/benefit analysis when considering their introduction. Some of the major issues that we would have to consider are the speed of obsolescence of the technology, the back-up systems we require should it fail, our staff training, and the equipment and software maintenance.

Task 5.11

Describe the main elements of your warehouse operation, or one that you are familiar with, which relate to the receipt of a product through to its eventual despatch

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Task 5.12

Describe in detail how you would prepare a customer's order, ensuring tight quality control, in your warehouse, or one that you are familiar with.